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OCCLUSION AND RHYTHM OF ERUPTION

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RESUME

L'établissement de l'occlusion à travers les phases successives de l'éruption dentaire a été la préoccupation de nombreux auteurs. Pour qu'il se fasse d'une façon harmonieuse, il faut que les séquences d'éruptions dentaires se déroulent correctement. Les auteurs ont étudié le rythme d'apparition sur arcade des dents permanentes et ont déterminé l'âge moyen d'éruption des canines, premières, secondes prémolaires et deuxième molaires. Les résultats sont donnés en fonction des 574 enfants de l'échantillon et en tenant compte du sexe.

ABSTRACT

Occlusion through successive phases of dental eruption was the concern of many authors.So that the progressive installation of occlusion is made harmonious way, it is necessary that the dental eruption sequences proceed correctly. The authors have studied rhythm appearence of permanent teeth, and they have determined the average eruption age of canines, first, second premolar and second molar. The results are given for the 574 children of the sample and following to the sex.

INTRODUCTION

"*Occlusion is the common denominator of the various components of manducator system : dental organ, Temporal-maxillary articulation, and neuromuscular system*" (Barelle)(2).

Occlusion through successive phases of dental eruption was the concern of many authors: they tried to define physiological and biological phenomena which come into play, between eruption and functionality of the teeth. But they especially showed the complexity which chairs this placing and interdependence which exists between eruption and occlusion.

So that the progressive installation of occlusion is made harmonious way, it is necessary that the dental eruption sequences proceed correctly, as like says Lafforgue (10) " the osseous growth and the dental eruptions are dependent phenomena in time ".

In fact occlusion use two factors: time and space. The time factor is consisted by successive eruption of temporary and permanent teeth ; space is made by agreement between course of the growth of dental units and osseous bases. In this case, occlusion will be equilibrated ; in the other case it is important to know the reasons because " The man can't keep the control on things if he don't learn the laws which they obey" (15).

Like said Baume, "normal eruption, from time and position of each individual tooth, is one of decisive events for teeth equilibrated development". Some authors define the departure of eruptive process when radicular formation is beginning (6): it's the activate period which succeeds passive pre-eruptive phase. Gradually, the tooth moves of its initial germinatif site towards the oral cavity: it's dental eruption. Eruption is constituted by the ensemble of tooth displacements since germ formation.This process is described in two phases:

During "pre-functional phase", the tooth walks on in alveolar bone, reaches gingival surface to lead to occlusal contact.

In "functional phase", there is continual adaptation to the osseous and dental modifications (dental growth, wear, versions,etc...).

During former search, it was identified many factors (genetic, physiological or pathological reasons) influencing significantly on the process of dental growth and occlusion ; those factors, modifying eruption, are much more : the germ trajectory and his speed movements can be modified by exogenic factors. Many authors recognize a relation between clinical emergency and calcification degree of the root. This relation is variable according to tooth, sex or with pathological factors. Classically we estimate that the tooth appear on the maxilla when the three thirds of the root are building. In this case, if the tooth as formed its three thirds of root, and it does not appear on the arcade, the tooth will be late of eruption (14).

The complex eruptive movements which affects tooth and alveolar bone will be mainly in axial direction. However, there are also movements in the three directions of space (rotation, version and translation side) (11). These movements relate to the intraosseous way and supra-gingival, and be continued very slowly during life (9).

These eruptive movements have not always the same rhythm and the tooth moves with a speed representing a balance between the forces tending to move it (eruptive force) and the forces tending to prevent its movement (resistance force). Each variation of these resistance forces will involve a modification of eruption speed whereas the eruption force will be unchanged. Many factors can influence this eruption speed and the big variations observed are not explained (11). But these changes of resistance force cannot justify all the modifications of eruption speed . This speed is not constant for all teeth. During root edification, it changes about 1,2 mm during a year for the third molar to 3,5 mm for the second lower premolar.

Others works showed that more is the tooth length, less is the eruption speed ; but this work was made with experiments on the continuous growth incisors and it is difficult to use the results from these studies for limited growth teeth of man. In fact phenomena, which are responsible for the inductive force of dental eruption and for different movements, depends of several factors (BERKOWITZ) (4).

Eruption of permanent teeth is normally preceded by the disappearance of temporary tooth ; when it's go away, the permanent tooth continues on one's eruption and the progressive replacement of temporary teeth carry on between 6 and 12 years old. The rhythm of this replacement, the direction of eruptive way and the final position of teeth are influenced by many factors (language, lips, suction of inch etc..) and are different for each individual. Moreover the chronology of eruption is not always the same for each quadrant of maxilla ; but it is possible to use statistical methods to consider an age average of arrival of the tooth.

The knowledge of this dental eruption age is important for us because it's better for diagnostic, therapeutic, or prognostic. And it's possible to have a good treatment when we meet a imbalance between osseous bases and dental organ. But existing reference works are old and it is essential to reactualize as well as possible the eruption ages to have a good approach of reality and to optimise the treatment of our patients. Indeed, from the chronology of eruption and the organisation of the dental units within their respective maxilla, will depend the balance and the stability of future occlusion (when there is a contact between the antagonist teeth)(7).

For better knowing the dental eruption ages, we chose to study the canines, premolars and second molars; in fact, the dental units are divided into two sectors: the canines form part of the ahead sector (under the influence of the neuromuscular system) and the premolars and molars belong to the posterior sector (which more depends of osseous growth). Moreover the canines and premolars eruption take place during one very short time and it's facilitated our investigation. Finally the importance of premolars and canines in the installation of balanced occlusion was approached by many authors : Bodart (5) recalls that the first lower premolar appears before its two neighbors. "Thus, its evolution is not disturbed by the bad positions of the neighbouring teeth, and the first lower premolar got a constant axis during its evolution since its coronary formation until its dental installation on maxilla ; moreover it's not tributary of bony displacement ; its position is just a little into the neuromuscular dependence".

Works of Moreira (in 5) showed that the higher canine keeps a constant axis since its coronary formation until root edification. This orientation exist because this tooth is located between an ahead zone influenced by the neuromuscular system and a posterior adaptation zone. It

moves in an stitch area corresponding to the pre-maxilla junction.

In the contacts of class 1 the anterior face of the first lower premolar cusp is in contact with the distal face of the upper canine; this one will place between lower premolar and canine so that its face is in contact with the distal face of the lower canine. The upper canines take place compared to the free edge of lower teeth. By covering partially the vestibular faces of the lower teeth, they create a guide and "it's axial inclination of the first lower premolar which determines the concept of the occlusion". (7).

The order of teeth appear can be the beginning of a bad occlusion; the two upper and lower premolars have a diameter lower than the temporary molars diameter; and in mixed set of teeth, if it exist imbalance between osseous bases and dental organs, the knowledge of the eruption rhythm allows the quickly identification of this imbalance; and we can guide the permanent eruption teeth (8). Many works were completed to determine an average age of dental eruption. The principal study relating to average eruption age of permanent teeth comes from United States and was undertaken by HURME, in 1948. This research was realized in eight different countries, with a big population (about 93000 children). He publishes its results : each average age of appearance of the teeth is given with standard difference concerning the maxilla according to the sex.

The other older work, completed by LOGAN and KRONFELD in 1933, supplemented by those of SCHOUR and MASSLER in 1940, is resumed in many publications (13, 16). However, recent studies revealed that techniques and methods used did not conclusive from the development and the growth of the individual.

In France, it exist only few studies about this theme. We can speak about the inquiry realized by TISSERAND-PERRIER, in 1958. This investigation made it possible to found a stage of silence (from 8 to 10 years old) between two great eruptive phases. It showed that the standard deviations concerning the canines, premolars and 2nd molar are more significant : the dispersion of the eruption ages tends to increase with average age of the appearance of tooth.

For these reasons, we studied the eruption sequences of the permanent teeth in a population of 5 years and a half to 15 years old children.

POPULATION AND STATISTICAL METHOD

We will determine an average eruption age for the canines, premolars and second permanent molars and will deduce one or more sequences " standard " eruption, according to the sex and the maxilla observed.

Population

Our sample is made up children examined in external hospital consultations and private consultations. The study relates to 574 children and teenagers (294 girls, 280 boys). The fist diagram shows the distribution of the children according to age and sex within our sample. The children were selected to following criterions:

- we don't examined the children getting an orthodontic treatment, or submit severe orthodontic malformations.
- we don't take children in same family.
- the subjects presenting significant local problems were excluded; or presenting disorders which can have an influence on child development.
- we don't selected child with many lacks of germ, and those presenting prematurely extracted teeth.

AGE	GIRLS	BOYS	TOTAL
5,5-6	4	2	6
6-6,5	3	1	4
6,5-7	5	3	8
7-7,5	3	4	7
7,5-8	23	28	51
8-8,5	19	27	46
8,5-9	25	16	41
9-9,5	25	21	46
9,5-10	20	14	34
10-10,5	24	12	36
10,5-11	26	27	53
11-11,5	25	25	50
11,5-12	37	31	68
12-12,5	21	28	49
12,5-13	15	17	32
13-13,5	7	9	16
13,5-14	6	7	13
14-14,5	5	4	9
14,5-15	1	4	5
TOTAL	294	280	574

Diag. I - Distribution of the children according to age and sex within the sample.

Collection of information

The whole of collected information about the 574 children belonging to our sample includes a total of more than 18 000 elementary information. Also we were brought to retain only the most significant parameters.

The investigated method is longitudinal, it's means that we look at each child only one time. Teeth permanent are examined and we consider the absence or the presence of teeth in oral cavity.

We think that a tooth is present, when an unspecified part of its crown is clinically detectable. So, we will symbolize it, by "1". In the contrary case, we will note "0".

Statistical method

Our statistical study consists of a descriptive analysis: for the calculation of the average age of eruption, we employ a graphic method of cumulated frequencies according to the age.

The children are divided by half years; we carry ages in X-coordinates, and in Y-coordinates the percentage of present tooth. We deduce from it thus easily the age to which 50% of the teeth made their eruption: it's median age. We consider this middle age as average age of eruption (even if this statistical method gives lightly earlier dates than average age), because the difference is negligible; and with the average eruption age, we indicate the standard deviation.

RESULTS AND DISCUSSION

The analysis relates to the following permanent teeth:

- Upper teeth (lateral incisors, canines, premolars and second molars),
- Lower teeth (canines, premolars and second molars).

With the average eruption age, we indicate the standard deviation. This one is calculated by the following formula:

$$\sigma = \frac{Q_3 - Q_1}{2 \times 0.6745}$$

(Q_3 corresponds to the level 75%, Q_1 is the level 25%, the results +/- σ thus include 68,26% of the children).

The diagrams II, III and IV indicate, for each considered tooth, the age of appearance of the teeth.

Diag. II – Average eruption age of permanent teeth in our sample, in years (y), months (m) and days (d). The standard deviations and intervals (M+/-s) are expressed in years and months.

Permanent teeth	SAMPLE				
	Average eruption age **M**	Standard deviation σ	Limits		Interval
			M - σ	**M + σ**	
Upper maxilla					
Central incisor	-	-	-	-	-
Lateral incisor	8y 00m 00d	1y 03m	6y 09m	9y 03m	2y 06m
Canine	10y 10m 10d	0y 11m	9y 09m	11y 09m	1y 10m
First premolar	10y 06m 18d	1y 04m	10y 02m	11y 10m	2y 08m
Second premolar	11y 03m 25d	1y 10m	9y 06m	13y 01m	3y 08m
First molar	-	-	-	-	-
Second Molar	11y 10m 28d	1y 08m	10y 03m	13y 07m	3y 04m
Mandible					
Incisors	-	-	-	-	-
Canine	10y 03m 00j	1y 00m	9y 03m	11y 03m	2y00m
First premolar	10y 04m 28j	1y 02m	9y 03m	11y 08m	2y 04m
Second premolar	11y 03m 25j	1y 08m	9y 08m	13y 00m	3y 04m
First molar	-	-	-	-	-
Second molar	11y 08m 05j	1y 1m	10y 07m	12y09m	2y 02m

Diag. III – Average eruption age of permanent girls' teeth in our sample in years (y), months (m) and days (d). The standard deviations and intervals (M+/-s) are expressed in years and months.

Permanent teeth	GIRLS				
	Average eruption age **M**	Standard deviation σ	Limits		Interval
			M - σ	**M + σ**	
Upper maxilla					
Central incisor	-	-	-	-	-
Lateral incisor	7y 09m 22d	1y 02m	6y 08m	9y 00m	2y 04m
Canine	10y 07m 10d	0y 10m	9y 09m	11y 05m	1y 08m
First premolar	10y 03m 00d	1y 05m	8y 10m	11y 08m	2y 10m
Second premolar	11y 04m 06d	1y 07m	9y 09m	12y11m	3y 02m
First molar	-	-	-	-	-
Second molar	11y 10m 06d	0y 11m	9y 11m	12y09m	1y 10m
Mandible					
Incisors	-	-	-	-	-
Canine	9y 08m 01d	1y 02m	8y 06m	10y 10m	2y04m
First premolar	10y 00m 14d	1y 00m	9y 00m	11y 00m	2y 00m
Second premolar	11y 04m 02d	1y 06m	9y 10m	12y 10m	3y 00m
First molar	-	-	-	-	-
Second molar	11y 07m 06d	1y 01m	10y 06m	12y 08m	2y 02m

Diag. IV – Average eruption age of the permanent boys' teeth in our sample in years (y), months (m) and days (d). The standard deviations and intervals (M+/-s) are expressed in years andmonths.

Permanent teeth	BOYS				
	Average eruption age **M**	Standard deviation σ	Limits		Interval **M+/-** σ
			M - σ	**M + σ**	
Upper maxilla					
Central incisor	-	-	-	-	-
Lateral incisor	8y00m 22d	0y10m	7y 03m	8y 11m	1y 08m
Canine	11y 00m 29d	0y05m	10y 08m	11y 06m	0y 10m
First premolar	10y 09m 22d	1y 00m	9y 10m	11y 10m	2y 00m
Second premolar	11y 03m 00d	1y 10m	9y 05m	13y 01m	3y 08m
First molar	-	-	-	-	-
Second molar	11y 10m 24d	1y 04m	10y 07m	13y 03m	2y 08m
Mandible					
Incisors	-	-	-	-	-
Canine	10y 07m 06d	0y 10m	9y 11m	11y 05m	1y 08m
First premolar	10y 07m 17d	0y 7m	10y 00m	11y 02m	1y 02m
Second premolar	11y 04m 02d	1y 11m	9y 05m	13y 03m	3y 08m
First molar	-	-	-	-	-
Second molar	11y 09m 14d	1y 01m	10y 08m	12y 10m	2y 02m

The interpretation of these diagrams encourages us to think that :

• The lower teeth generally appear before their upper counterparts. this precocity of the mandible on the jawbone is observed for all the studied teeth of our sample, except the second lower and upper premolars which appear at the same time (11 years and 4 months).

• Our objective is to present the most probable sequence of eruption in the average child (with 6 months of interval age). We note that the eruption sequence is different between upper maxilla [side incisor, then first premolar, canine, second premolar, then second molar (2 – 4 – 3 – 5 –7)] and mandible [where we note an inversion in the eruption order between canine and first premolar (3 – 4 – 5 – 7)].

• It does not have there or little significant difference between the two maxillary sides (the most significant difference being about 4 months for upper canine). Thus, we can neglect the difference between right and left side as well as lower and upper maxilla (this difference being on average of 1 month and 1 week).

• We observe a light girls' precocity for all the studied teeth, if we rule out the second upper premolar (precocity for boys) and second lower premolar or second upper molar (which appear at the same time for the two sexes). Thus, at the mandible, except for the second premolar which is synchronous with girls and boys, male sex is an unquestionable delayed on female sex. This delay reached:

- 2 months for the second molar,
- 7 months for the first premolar,
- 13 months for the canine.
- With the jawbone, the delay between boys and girls is less important. It reaches 3 months for the side incisors, 6 months for the canine and the first premolar. The second molars are synchronous in the two sexes.
- We note a later eruption of the upper teeth compared to the counterparts for boys; the maximum shift being 6 months for the upper canine.
- Same observation for girls with a maximum shift of 1 year for the upper canine, if we rule out the second premolars which are synchronous (11ans, 4 months); we note, in the two sexes, an eruption delay of upper teeth by comparison with their lower counterparts (with a maximum delay of 12 months for the upper girl's canine.

The standard deviations are variable but approximately about 1 year for girls and boys, but more significant for the second upper and lower premolars (approximately 2 years).

The profile of the average eruption ages, according to the sexe shows us one period "of lull" between the two eruptive moments. The composition of our sample does not allow us to study the length of the first eruptive period but it's possible to quantify the length of the second one.

Comparative study with other reference works

Eruption sequence of upper teeth

The eruption sequence, in our sample, is identical to investigation of TISSERAND-PERRIER in 1958 (4 – 3 – 5 – 7). Whereas for HURME, the canine appears after first and second premolar (4-5-3-7).

Eruption sequence of lower teeth

We have a sequence of eruption which is identical to investigations of TISSERAND-PERRIER and HURME (3– 4 – 5 – 7).

Average eruption age

We joined together our results with those of TISSERAND–PERRIER and HURME in diagrams V and VI. We standardized their results to compare them by expressing the average eruption ages in years and months (the two sexes confused).

The work of TISSERAND and PERRIER is the only inquiry in France, with the same statistical method and the same way of eruption evaluation. The work of HURME is still regarded today as the reference about the eruption ages.

By comparison with the children of the investigation of TISSERAND–PERRIER in 1958, we observe in our sample:

• a light advance for the side upper incisor (1 month) and the second upper molar (3 months),

• an average identical age of eruption for the upper canine in the two investigations,

• a delay for the lower canine and second premolar as well as first and second upper premolar, whose eruption takes place 1 to 4 months later in our sample.

Diag.V – Comparison of the average eruption ages of the permanent upper teeth.

	Lateral incisor	Canine	1st Premolar	2nd Premolar	2nd Molar
TISSERAND–PERRIER (FRANCE-1958)	8y 1m	10y 10m	10y 4m	11y	12y 2m
Sample (France-1998)	8y	10y 10m	10y 6m	11y 4m	11y 11m
HURME (USA-1948)	8y 5m	11y 4m	10y 3m	11y	12y 6m

Diag. VI – Comparison of the average eruption ages of the permanent lower teeth.

	Canine	1st Premolar	2nd Premolar	2nd Molar
TISSERAND–PERRIER (FRANCE-1958)	10y 2m	10y 5m	11y 3m	11y 9m
Sample (France-1998)	10y 3m	10y 4m	11y 4m	11y 8m
HURME (USA-1948)	10y 4m	10y 6m	11y 3m	11y 11m

The greatest differences observed between these two investigations relate the upper teeth (advances 3 months for the 2nd molar and delay of 4 months for the 2nd premolar for our sample) whereas the differences are less significant with lower teeth (about 1 month).

The children which are examined by TISSERAND-PERRIER in 1958 and those of our sample are earlier comparatively with the children's inquiry of HURME in 1948 (for all the teeth studied, except first and second upper premolars).

Standard deviations

We calculated the standard deviations of our sample starting from the same formula as that used by HURME and TISSERAND-PERRIER for them works.

The comparison of our results with those show us weaker standard deviations for our sample (whose standard deviation is on average 14 months, whereas it is15 months for TISSERAND-PERRIER and 16 months for HURME).

Diag. VII – Comparison of the average eruption ages of the permanent lower canine. According to sex, within the three inquiries.

	GIRLS	BOYS
TISSERAND–PERRIER (FRANCE -1958)	9y 8m	10y 9m
Sample (France-1998)	9y 8m	10y 7m
HURME (USA-1948)	9y 10m	10y 9m

For boys, if we compare with lower teeth, we note an later eruption for upper teeth. In the three studies, we have a maximal difference for upper canines :

- -5 months (TISSERAND-PERRIER)
- -6 months (our sample)
- -11 months (HURME)

For girls, we have the same difference for upper canines with:

- -10 months (TISSERAND-PERRIER)
- -12 months (our sample)
- -14 months (HURME)

CONCLUSION

The results of our study about dental eruption confirm:

- The eruption sequence is different for upper or lower teeth,
- The eruption is usually more later for upper teeth,
- Boys' teeth appear more later than girls' teeth.

We can give the average age of dental eruption with an easy drawing :

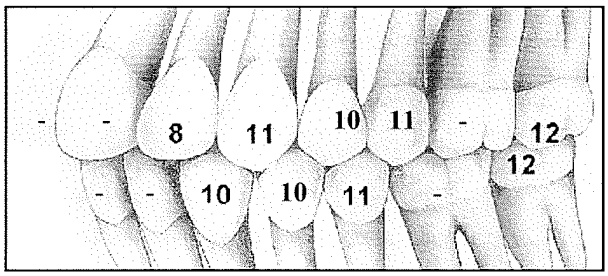

Fig. 1 - Average eruption age of permanent teeth within our sample.

Our study is very near the inquiry of TISSERAND-PERRIER, but we have some difference :

- Eruption is belated for upper premolars in our population,
- Eruption is earlier for the second upper molar (11years and 11 months old for our children, 12 years and 2 months for TISSERAND-PERRIER).

The results of HURME' s work are different, and the average age of eruption are belated (5-7 months for upper teeth, 1-3 months for lower teeth).

We must except premolars, which present an belated eruption in our sample (1-4 months after the eruption ages of HURME' s work).

This delay could be explained by:

- The phylogenetic reduction of the maxilla during the human evolution ; we can meet children which present a lack of space (slowing down the eruption of one or more groups of teeth),
- Tooth of "discontinued line" (second premolar) which appears when we observes a deceleration of growth,
- Progress as regards Prevention and preserving care in Paediatric Odontology which allows a longer conservation of the temporary molars.

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